Effect of Interior Carton Coatings on the Retention of Lettuce Quality

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ABSTRACT

Head lettuce stored 1 or 3 weeks at 5°C in fiberboard cartons coated internally with wax or plastic had about the same general quality and incidence of specific defects as lettuce packed in conventional, untreated cartons. Lettuce stored in coated cartons lost one-third as much moisture as lettuce stored in uncoated cartons. Actual weight loss in coated cartons was 0.2 and 0.7 percent after 1 and 3 weeks, respectively, and 0.8 and 2.4 percent in untreated cartons. Wax or plastic coatings on cartons significantly reduced moisture absorption by the fiberboard during storage.

KEYWORDS: Curtain-coated cartons, plastic-coated cartons, wax-coated cartons, fiberboard, lettuce, shipping cartons, unitization.

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CONTENTS

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EFFECT OF INTERIOR CARTON COATINGS ON THE RETENTION OF LETTUCE QUALITY

By C. Max Harris[1]

INTRODUCTION

Recently, the western lettuce industry has shown an increased interest in unitization. Many companies are developing systems for unitizing cartons of film wrapped and unwrapped (naked packed) lettuce.

Unitization involves the development of a stable, uniformly alined unit composed of stacked lettuce cartons that can be handled mechanically. Performance of lettuce cartons, particularly in regard to stacking strength, becomes critical if the unitization system is to be successful at both shipping point and destination markets.

Previous research (*2*, *7*)[2] has shown that stacking strength of fiberboard cartons is reduced as the moisture content of the fiberboard increases. Wax coatings substantially reduce moisture penetration into fiberboard (*4*) and thus help maintain a drier, stronger carton.

Previous shipping tests of naked-pack lettuce from California to eastern markets (*4*) showed that experimental fiberboard cartons that were wax coated on all surfaces arrived with less crushing damage than uncoated cartons of the same initial board strength. That study also indicated that slightly more decay occurred in waxed than in unwaxed cartons. According to these tests, moisture-resistant coatings improved the physical strength of the cartons, and, thus, their performance in lettuce unitization systems; however, the effect of various carton coatings on the overall quality of lettuce during storage was not clear. Thus, it was necessary to determine the effect of various interior carton coatings on storage quality and postharvest defects of lettuce.

MATERIALS AND METHODS

Three types of coated cartons were studied:

1. Wax dipped

Cartons of this type were dipped in a vat of wax so that all surfaces were wax coated.

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[2]Italic numbers in parentheses refer to Literature Cited, p. 6.

2. "Curtain coated"

The interior surfaces were impregnated with a layer of hot wax immediately after the fiberboard was formed.

3. Plastic coated

The interior surfaces were coated with a water resistant plastic polymer. This material was designed for use as a moisture resistant coating for fiberboard cartons and is applied as a water-based emulsion. A conventional untreated fiberboard carton was included as a control.

Wax coatings (saturating wax No. 2, Chevron Chemical Company, San Francisco, Calif.) for the test cartons using wax, were applied by the box manufacturers using commercial application techniques. We applied the plastic coating (X-300 coating, Mechelman Chemicals Company, Cincinnati, Ohio) to cartons with a brush and squeegee wiper blade.

All test cartons used were the standard size (85-40 flat-pack) and standard fiberboard strength (300 lb (134.4 kg) Mullen test) normally used by the lettuce industry. All cartons had two vents, measuring 0.5 inch (1.3 cm) by 3 inches (7.6 cm) in each end surface, and the standard gap between the flaps in the top and bottom surfaces (about 6 inches (15.2 cm) by 0.75 inch (1.9 cm)).

We conducted 13 storage tests during the 1978 and 1979 seasons. In eight of these, lettuce samples were obtained from the Salinas or Watsonville coastal areas, and in five tests, samples were obtained from the Blythe or El Centro desert areas.

Commercial packing crews cut the lettuce and packed four cartons of each type for each storage test. The four types of cartons were randomized prior to packing and were packed in the same part of the field to obtain uniform lettuce samples. All test lettuce was cooled in a vacuum cooler along with a commercial load of lettuce.

The packed cartons were transported by refrigerated truck to the Fresno laboratory where they were stored at 5°C (41°F). One-half of the lettuce from two cartons of each type was examined after 1 week, and the remaining lettuce was examined after 3 weeks. The first storage period (1 week at 5°C) was chosen to simulate typical marketing conditions for lettuce. The second storage period (3 weeks at 5°C), which is longer than most lettuce is stored before being consumed, was chosen to assure that ample storage defects would be present in all samples for treatment comparisons.

The relative humidity of the cold room where the lettuce was stored was measured at intervals during the tests with a dewpoint hygrometer and ranged from 85 to 95 percent.

The following weights were recorded for each carton: (1) Initial tare weight, (2) packed weight prior to storage, (3) packed weight upon removal from storage, and (4) final tare weight immediately after removal of lettuce from the carton.

Individual heads of lettuce were rated for general visual appearance (both before and after trimming) and for storage defects (5).

RESULTS

Visual Quality

There were no significant differences in the visual quality of lettuce that could be attributed to the various carton types tested. At the first examination, average external appearance ratings (before trimming) for desert lettuce, were lower than those for coastal lettuce because of freezing and other damage on wrapper leaves of some samples. After 3 weeks, decay was the primary factor that determined lettuce appearance. At this time, decay was generally more severe in coastal than in desert lettuce, and thus the average external appearance ratings were higher in desert than in coastal lettuce, a reversal from the first examination (table 1).

Table 1.--*Appearance rating of lettuce after storage in various types of cartons for 1 or 3 weeks at 5°C (41°F)*

Carton type	External appearance ratings[1]				Average all examinations
	Coastal lettuce[2]		Desert lettuce[3]		
	Before trim	After trim	Before trim	After trim	
Examination 1:[4]					
Untreated	6.2	6.6	5.4	6.3	6.1
Plastic coated	6.3	6.7	5.6	6.5	6.3
Wax curtain coated	6.4	6.6	5.4	6.6	6.2
Wax dipped	6.4	6.7	5.5	6.4	6.2
Examination 2:[5]					
Untreated	3.4	3.8	4.0	5.2	4.1
Plastic coated	3.2	3.9	4.0	5.3	4.0
Wax curtain coated	3.1	3.7	4.2	5.5	4.1
Wax dipped	3.4	3.9	4.2	5.5	4.2

[1]External appearance ratings: 1 = unsalable, 3 = poor, 5 = fair, 7 = good, 9 = excellent.

[2]Average of 8 replicated tests. Lettuce obtained in the Salinas and Watsonville areas.

[3]Average of 5 replicated tests. Lettuce obtained in the El Centro and Blythe areas.

[4]Examined after 1 week at 5°C.

[5]Examined after 3 weeks at 5°C.

Decay

The type of carton used had no significant effect on the amount of severity of decay that developed in lettuce during either storage period.

After 1 week at 5°C, decay was minor in lettuce from both growing regions and was confined mostly to wrapper leaves.

At the second examination, the incidence of decay averaged 93 percent in coastal lettuce and 88 percent in desert lettuce before trimming. After trimming, which included removal of the cap leaves, decay averaged 75 percent in coastal lettuce and 26 percent in desert lettuce. When lettuce with a decay severity rating of 4[3] or lower was excluded, decay amounted to 64 percent in coastal lettuce and 31 percent in desert lettuce before trimming and 40 percent in coastal lettuce and 11 percent in desert lettuce after trimming.

Other Defects

Tipburn, russet spotting, rib discoloration, and brown stain occurred infrequently and erratically in the various tests; therefore, no evaluations could be made of these defects.

The incidence of pink rib, which did not differ significantly in the various types of cartons used, was primarily related to cultivar. The coastal cultivar 'Salinas' and the desert cultivar 'Empire' were most susceptible to this disorder and were severely affected after 3 weeks at 5°C.

Weight Loss of Lettuce

Lettuce samples from the desert and coastal growing areas lost similar amounts of moisture during storage; therefore, weight-loss data from the two areas were combined.

Lettuce stored in untreated cartons had lost 0.8 percent of its initial weight after 1 week and 2.4 percent after 3 weeks of storage at 5°C (table 2); however, weight loss from lettuce in wax-dipped, curtain-coated, and plastic-coated cartons was about equal and was only one-fourth that of lettuce stored in untreated cartons.

Weight Change of Cartons

All test cartons gained weight during storage due to an increase in moisture uptake by the fiberboard material used in the cartons. Conventional untreated cartons had a weight gain average of 15.6 percent after 1 week and 17.5 percent after 3 weeks of storage at 5°C (table 3). Weight gains among the three types of coated cartons were similar but about one-third lower than those of the controls.

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[3]Decay rating: 1 = none; 3 = slight, slightly objectionable, may impair salability; 5 = moderate, objectionable, definitely impairs salability; 7 = severe, salvageable but normally not salable; 9 = extreme, not usable.

Table 2.--*Effect of carton coatings on weight loss of lettuce*[1] *during storage at 5°C (41°F)*

Carton type	Weight loss[2]	
	After 1 week storage at 5°C	After 3 weeks storage at 5°C
	Percent	*Percent*
Untreated	0.8 a	2.4 a
Plastic coated	.3 b	.9 b
Wax curtain coated	.1 b	.6 b
Wax dipped	.1 b	.6 b

[1]Average of 13 tests from both coastal and desert growing areas.

[2]Mean separation within columns by Duncan's multiple range test, 1-percent level.

Table 3.--*Influence of coatings on weight gain of fiberboard cartons*[1] *during storage at 5°C (41°F)*

Carton type	Weight gain[2]	
	After 1 week storage at 5°C	After 3 weeks storage at 5°C
	Percent	*Percent*
Untreated	15.6 a	17.5 a
Plastic coated	10.5 b	12.0 b
Wax curtain coated	8.6 b	10.0 b
Wax dipped	8.9 b	11.8 b

[1]Average of 8 tests from both coastal and desert growing areas.

[2]Means separation within columns by Duncan's multiple range test, 1-percent level.

DISCUSSION

The type of carton in which lettuce was stored had no influence on the incidence of decay in these tests; however, moderate and severe decay occurred more than twice as often in coastal lettuce as it did in desert lettuce. Most of the decay was located on the outer wrapper leaves of the lettuce heads in both growing areas, a finding that is in agreement with earlier results (*8*, *9*). Consequently, elimination of wrapper leaves likely would reduce the incidence of decay in lettuce during long term storage. Wrapper leaves provide physical protection for naked-packed lettuce, and their elimination would require the development of a serviceable protective package for lettuce (*3*).

Work by Garrett et al. (*1*) showed that, in a refrigerated room with minimal air movement, lettuce in wax-coated cartons cooled at a slower rate than lettuce in uncoated cartons; however, since all commercially packed lettuce is vacuum precooled, these findings by Garrett do not preclude the use of coated cartons for lettuce. A slower cooling rate for lettuce in coated cartons would add to temperature maintenance problems in shipments in which lettuce had not been precooled to the proper temperature, or in which excessive warming was permitted during transfer from the vacuum cooler to the transporting vehicle. Even if heat transfer through the coated cartons were impaired slightly, proper placement of enlarged, cleanly cutout vents in lettuce cartons would increase the precooling rate for lettuce (*6*).

In these tests, pink rib was a serious defect only after the second examination (3-week storage period) when most trade lettuce would expectedly be consumed. Some cultivars, however, were more susceptible to this disorder than others, and pink rib may become a serious problem during the normal commercial handling of lettuce.

Lettuce in uncoated cartons lost more weight during storage than lettuce in coated cartons because moisture was transferred at a faster rate from the lettuce through the untreated fiberboard material to the ambient air. This increased moisture transfer is reflected in the greater weight gain by uncoated than by coated cartons during storage.

Results of these tests indicate that lettuce, when handled properly, can be shipped in wax- or plastic-coated cartons without suffering significant losses in quality as compared with lettuce shipped in uncoated cartons and thus can benefit from the greater physical protection provided by cartons having moisture resistant coatings.

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